TABLE 52. ANNUAL COST FOR CSO SLUDGE HANDLING

	Size of CSO area			
	500 acres	5700 acres	25,000 acres	60,000 acres
Treatment alternative		Cost in dollars		
Alternative 1:				
Biological sludge	$283,000	$1,239,000	$ 3,651,000	$ 8,018,000
DAF sludge	204,000	660,000	2,300,000	4,500,000
Alternative 2:				
Biological sludge	254,000	1,055,000	3,472,000	$ 6,930,000
DAF sludge	183,000	590,000	1,917,000	3,637,000
Alternative 3:				
Biological sludge	330,000	1,012,000	4,053,000	$ 8,446,000
DAF sludge	106,000	360,000	2,246,000	3,328,000
Alternative 4:				
Biological sludge	266,000	1,965,000	10,379,000	26,121,000
DAF sludge	105,000	849,000	2,912,000	5,764,000
$/acre	$210-$660	$64-$345	$77-$415	$56-$435
$/ton of dry solids	$347-$1140	$188-$483	$193-$581	$162-$610

Acres x 0.405 = ha
Tons x 0.907 = metric tons

TABLE 53. CAPITAL COST INFORMATION* FOR CSO SLUDGE HANDLING

	Size of CSO area			
	500 acres	5700 acres	25,000 acres	60,000 acres
Treatment alternative	Cost in dollars			
Alternative 1:				
Biological sludge	$2.06 x 10^6	$8.43 x 10^6	$22.54 x 10^6	$52.54 x 10^6
DAF sludge	1.49 x 10^6	5.37 x 10^6	16.94 x 10^6	38.17 x 10^6
Alternative 2:				
Biological sludge	1.86 x 10^6	7.48 x 10^6	20.86 x 10^6	46.76 x 10^6
DAF sludge	1.39 x 10^6	5.29 x 10^6	14.85 x 10^6	32.37 x 10^6
Alternative 3:				
Biological sludge	0.74 x 10^6	4.56 x 10^6	14.48 x 10^6	34.07 x 10^6
DAF sludge	0.53 x 10^6	2.37 x 10^6	8.69 x 10^6	14.68 x 10^6
Alternative 4:				
Biological sludge	0.54 x 10^6	2.36 x 10^6	10.68 x 10^6	26.36 x 10^6
DAF sludge	0.42 x 10^6	1.03 x 10^6	6.36 x 10^6	14.49 x 10^6
$/acre	$840-$4120	$181-$1479	$254-$902	$242-$876
$/ton of dry solids	$1310-$8660	$538-$2804	$598-$2018	$616-$1892

* All handling and distribution costs for land application were considered operating only.

Acres x 0.405 = ha
Tons x 0.907 = metric tons

SECTION IX

REFERENCES

1. "Problems of Combined Sewer Facilities and Overflows - 1967," American Public Works Association, USEPA Report No. 11020-12/67, NTIS-PB 214 469, 1967.

2. "Pollutional Effects of Stormwater and Overflows from Combined Sewer Systems", U.S. Department of Health, Education and Welfare PHS Publication 1246, Washington, D.C., 1964.

3. Camp, T.R., "Overflows of Sanitary Sewage from Combined Sewer Systems", Jour. Water Poll. Control Fed., 31, 281 (1959).

4. Benjes, H.H., et al., "Storm Water Overflows from Combined Sewer Systems", Jour. Water Poll. Control Fed., 33, 1252 (1961).

5. "Storm and Combined Sewer Demonstration Projects", Water Pollution Control Series, EPA Report No. EPA-11000-01/70, NTIS-PB 190-799, January, 1970.

6. Field, R., and Struzeski, Jr., E. J., "Management and Control of Combined Sewer Overflows", Jour. Water Poll. Control Fed., 44, 7 (1972).

7. "Combined Sewer Overflow Seminar Papers", USEPA Report No. EPA-670/2-73-077, NTIS-PB 231 836, November 1973.

8. D E L E T E

9. Lager, J. A., and Smith, W. G., "Urban Stormwater Management and Technology: An Assessment", USEPA Report No. EPA-670/2-74-040, NTIS-PB 240 687 , September 1974.

10. American Sewage Practice, Volume I: Design of Sewers, Metcalf and Eddy, Inc., 2nd Edition, McGraw-Hill Book Co., New York, New York, 1928.

11. Linsley, R. K., Kohler, M. A. and Paulkus, J. L. H., Applied Hydrology, McGraw-Hill Book Co., New York, New York, 1949.

12. Clark, M. J., et al., "Handling and Disposal of Sludges from Combined Sewer Overflow Treatment-Phase I (Characterization)," USEPA Report No. EPA-600/2-77-053a, NTIS-PB 270 212, May 1977.

13. Farrell, J. B., Overview of Sludge Handling and Disposal, Proceedings Pretreatment and Ultimate Disposal of Wastewater Solids, Rutgers University, May 21-22, 1974, p. 1-22.

14. Metcalf and Eddy Inc., Wastewater Engineering: Collection Treatment, and Disposal, McGraw-Hill Book Co., New York, New York, 1972.

15. WPCF and ASCE, Design and Construction of Sanitary and Storm Sewers, WPCF Manual of Practice No. 9, 1970.

16. "Process Design Manual for Suspended Solids Removal", USEPA Technology Transfer, USEPA Report No. EPA-625/1-75-003a, January, 1975.

17. "WPCF Manual of Practice No. 8: Sewage Treatment Plant Design", American Society of Civil Engineers and Water Poll. Control Federation, 1959.

18. "Recommended Standards for Sewage Works", Health Education Service, Albany, New York, 1973.

19. "Process Design Manual for Upgrading Existing Wastewater Treatment Plants", USEPA Technology Transfer, October, 1974.

20. Burd, R. S., "A Study of Sludge Handling and Disposal", USEPA Report No. EPA-17070-___ 05/68, NTIS-PB 179 514, May 1968.

21. McCarty, P. L., "Sludge Concentration-Needs, Accomplishments, and Future Goals", Jour. Water Poll. Control Fed., 38, 493 (1966).

22. "Process Design Manual for Sludge Treatment and Disposal", USEPA Technology Transfer, USEPA Report No. EPA-635/1-74-006, October, 1974.

23. Maruyama, T., et al., "Metal Removal by Physical and Chemical Treatment Processes", Jour. Water Poll. Control Fed., 47, 962 (1975).

24. "Toxic Materials Analysis of Street Surface Contaminants", Environmental Protection Technology Series. USEPA Report No. EPA-R2-73-283, NTIS-PB 224 677, August 1973.

25. Ghosh, M. M., and Zugger, P. D., "Toxic Effects of Mercury on the Activated Sludge Process", Jour. Water Poll. Control Fed., 45, 424 (1973).

26. "Interaction of Heavy Metals and Biological Sewage Treatment Processes", Environmental Health Series, Water Supply and Pollution Control, US Public Health Service, May, 1975.

27. Dube, D. J., et al., "Polychlorinated Bi-Phenyls in Treatment Plant Effluents", Jour. Water Poll. Control Fed., 46, 966 (1974).

28. "Water Quality Criteria", Report of the National Technical Advisory Committee to the Secretary of the Interior, FWPCA, Washington, D.C., April, 1968.

29. Sartor, J. D., and Boyd, G. B., "Water Pollution Aspects of Street Surface Contaminants", USEPA Report No. EPA-R2-72-081, NTIS-PB 214 408, November, 1972.

30. Babbitt, H. E., Sewage and Sewage Treatment, John Wiley and Sons, Inc., New York, New York, 1953.

31. Tarvin, D., "Metal Plating Wastes and Sewage Treatment", Sewage and Industrial Wastes, 28, 1371 (1956).

32. Morrison, S. M. and Martin, K. L., Lime Disinfection of Sewerage Bacteria at Low Temperature, paper presented at the International Symposium on Research and Treatment of Wastewaters in Cold Climates, Univ. of Sakatchewan, Saskatchewan, Canada, August, 1973.

33. Riehl, M. L., Weiser, H., Rheins, B. T., Effect of Lime-Treated Water on Survival of Bacteria, Journal American Water Works Association, 44, 5, 466-470, May, 1952.

34. Farrell, J. B., Smith, J. E., Jr., Hathaway, S. W., Deen, R. B., Lime Stabilization of Primary Sludges, Journal WPCF, 46, 1, 113-122, January, 1974.

35. Counts, C. A., and Schuckrow, A. J., "Lime Stabilized Sludge: Its Stability and Effect on Agricultural Land", EPA Report No. 670/2-75-012, NTIS-PB 241 809, April 1975.

36. Metcalf and Eddy, "Water Pollution Abatement Technology, Capabilities and Cost", National Commission on Water Quality, Report No. PB-250 690, March 1976.

37. USEPA, "Guidelines for the Land Disposal of Solid Wastes", Federal Register; 40 CFR, 241.

38. USEPA, "Municipal Sludge Management Environmental Factors", Proposed Technical Bulletin, MCD-28, June 1976.

39. Sanitary Landfill Facts, US Department of Health, Education and Welfare, 1970.

40. Battelle Memorial Institute, "Municipal Sewage Treatment - A Comparison of Alternatives", Report prepared for CEQ, Contract EQC 316, February, 1974.

41. Sullivan, R., et al., "The Swirl Concentrator as a Grit Separator Device", USEPA Report No. EPA-670/2-74-026, NTIS-PB 233 964 June 1974.

42. Smith, J. E., and Rosenkranz, W. A., "Municipal Sludge Management Research Program in the U.S.A.", Presented at US/USSR Seminar, Moscow, USSR, May 1975.

43. Metcalf and Eddy, "Water Pollution Abatement Technology Capabilities and Cost", National Commission on Water Quality PB-250 690 1976.

44. "Pretreatment and Ultimate Disposal of Wastewater Solids", Proceedings of Research Symposium, Rutgers University, May 1974.

45. Pound, C. E. and Crites, R. W., "Wastewater Treatment and Reuse by Land Application", USEPA Report No. EPA-660/2-73-006, Volumes I and II, August 1973.

46. EPA Technology Transfer, "Land Treatment of Municipal Wastewater Effluents", USEPA Report No. EPA-625/1-77-008, October 1977.

47. Metcalf and Eddy, Inc., "Evaluation of Land Application Systems", USEPA Report No. EPA-430/9-75-001, March 1975.

48. Pounds, C. E., Crites R. W., and Griffes, D. A., "Costs of Wastewater Treatment by Land Application", USEPA Report No. EPA-430/9-75-003, June 1975.

49. US Environmental Protection Agency, "Manual for Evaluating Public Drinking Water Supplies", p. 4-12, 1971; Updated with "Proposed Primary Drinking Water Regulations", June 1975.

50. Dardos, L. L., et al., "Renovation of Secondary Effluent for Reuse as a Water Resource", USEPA Report No. EPA-660/2-74-016, NTIS-PB-234 176, February 1974.

51. Environmental Protection Agency, "Alternative Waste Management Techniques for Best Practicable Waste Treatment", Report No. 430/9-75-013, October 1975.

52. Morris, C. E., and Jewell, W. S., "Regulations and Guidelines for Land Application of Wastes - A 50 State Overview", Paper presented at the 8th Annual Cornell University Agricultural Waste Management Conference, Rochester, New York, April 1976.

53. Great Lakes - Upper Mississippi River Board of State Sanitary Engineers, "Recommended Standards for Sewage Works", Addendum No. 2 - Ground Disposal of Wastewaters, April 1971.

54. Whiting, D. M., "Use of Climatic Data in Dosing of Soils Treatment Systems, "USEPA Report No. EPA-660/2-75-018, July 1975.

55. Thomas, R. E., "Fate of Materials Applied", Paper Presented at Conference on Land Disposal of Wastewaters, Michigan State University, December 1972.

56. Stevens, R. M., "Green Land-Clean Streams: The Beneficial Use of Waste Water Through Land Treatment", Center for the Study of Federalism, Temple University, Philadelphia, PA, 1972.

57. Zimmerman, J. P., Irrigation, John Wiley and Sons, Inc., New York, New York, 1966.

58. "Handbook", Rain Bird Sprinkler Manufacter Corporation, Glendora, GA 1971.

59. Demirjian, Y. A., "Design Seminar for Land Treatment of Municipal Wastewater Effluents: Muskegon County Wastewater Management System", USEPA Technology Transfer, April 1975.

60. Department of Natural Resources, "Guidelines for the Application of Wastewater Sludge to Agricultural Land in Wisconsin", Technical Bulletin No. 88, Madison, WI 1975.

61. Cornell University, "Land Application of Wastes - An Educational Program", Workshop sponsored by EPA, May 1976.

62. Sopper, W. E., "Crop Selection and Management Alternatives - Perennials", Proceedings of Joint Conference on Recycling Municipal Sludges and Effluents on Land, University of Illinois, July 1973.

63. Walker, J. M., "Trench Incorporation of Sewage Sludge", Municipal Sludge Management, USEPA and ASCE, June 1974.

64. Manson, R. L., and Merritt, C. A., "Land Application of Liquid Municipal Wastewater Sludges", Jour. Water Poll. Control Fed., 47, 20, 1975.

65. Chaney, R. L., "Recommendations for Management of Potentially Toxic Elements in Agriculture and Municipal Wastes", in National Program Staff, Factors Involved in Land Application of Agricultural and Municipal Wastes, Agriculture Research Service, Soil, Water and Air Services, USDA, Beltsville, Maryland, pp 97-120, 1974.

66. Jewell, W. A., "Organic Assimulation Capacities of Land Treatment Systems Receiving Vegetable Processing Wastewater", 31st Industrial Waste Conference, Purdue University, West Lafayette, IN 1976.

67. Culp, G., "Design Seminar for Land Treatment of Municipal Wastewater Effluents: Example Comparisons of Land Treatment and Advanced Waste Treatment", USEPA Technology Transfer, April 1975.

68. Burd R. S., "A Study of Sludge Handling and Disposal", USEPA Report No. EPA-17070--05/68, NTIS-PB 179 514, May 1968.

69. Building Construction Cost Data, 1976, Robert Snow Means Company, 34th Annual Edition, p. 184.

70. US Environmental Protection Agency, Office of Water Program Operations, Municipal Construction, Division, Sewage Treatment Plant and Sewage Construction Cost Indexes, 1976.

71. Ehlich, W. F., "Economics of Transport Methods of Sludges", Presented at the 3rd National Conference on Sludge Management, Disposal and Utilization, Miami, FL, December 14-16, 1976.

72. Wolf, T. F., "Sludge Handling Facilities-Sewerage Commission of the City of Milwaukee", Inter-Department Memorandum, June 12, 1975.

73. Personal Communication, Mr. Frank Munsey, Process Supervisor Engineer - Milwaukee Metropolitan Sewerage District to Mrs. Kathryn Huibregtse, Envirex.

74. Linsley Jr., R. K., et al., Hydrology for Engineers, McGraw-Hill Books Co., New York, New York, 1958.

75. Heaney, J. F., et al., "Nationwide Evaluation of Combined Sewer Overflows and Urban Stormwater Discharges, Vol. II: Cost Assessment and Impacts," USEPA Report No. EPA-600/2-77-064(b), NTIS-PB 266 005, March 1977.

76. Sullivan, R. H., et al., "The Swirl Concentrator as a Grit Separator Device," USEPA Report No. EPA-670/2-74-026, NTIS-PB 233 964, June 1974.

77. EPA Technology Transfer, "Swirl Device for Regulating and Treating Combined Sewer Overflows," USEPA Report No. EPA-625/2-77-012, 1977.

78. Sullivan, R. H., et al., "Field Prototype Demonstration of the Swirl Degritter," USEPA Report No. EPA-600/2-77-185, NTIS-PB 272 668, September 1977.

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16 ABSTRACT

This report documents the results of an assessment of the effort that the United States will have to exert in the area of sludge handling and disposal if, in fact, full-scale treatment of combined sewer overflows is to become a reality. The results indicate that nationwide an average yearly sludge volume of 156 x 10^6 cu m (41.5 x 10^9 gal.) could be expected from CSO if complete CSO treatment were achieved.

Evaluation of the effect of bleed/pump-back of CSO sludge on the hydraulic, solids and/or organic loadings to the dry-weather plant indicated that overloading would occur in most instances. The most promising treatment trains were found to include possible grit removal, lime stabilization, optional gravity thickening, optional dewatering and land application or landfill. Land application systems can be considered as viable alternatives for CSO treatment and disposal.

Costs for overall CSO sludge handling depend on the type of CSO treatment process, volume and characteristics of the sludge and the size of the CSO area, among other considerations. Estimates indicate that first investment capital costs range from $447-10,173/ha ($181-4129/ac) with annual costs of $139-1630/ha ($56-660/ac).

17. KEY WORDS AND DOCUMENT ANALYSIS

a DESCRIPTORS	b IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Combined sewers Sludge Sludge disposal Thickening Dewatering	Lime stabilization Land application Bleed/pump/back Sludge characterization Sludge treatment	13B

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